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SOWING FLAX ON WINTERKILLED WHEAT FIELDS.[1]

By M. W. Evans, *Scientific Assistant, Forage-Crop Investigations.*

INTRODUCTION.

Wherever wheat is sown in the fall and the climatic conditions during the winter are unfavorable, it is more or less subject to injury by winterkilling. Great losses are sometimes sustained in the winter-wheat areas of the United States from this cause.

The farmers in the vicinity of New London, in northern Ohio, have found a way to avoid much of this loss. When the stand of

Fig. 1.—A field of fall-sown wheat and spring-sown flax at New London, Ohio.

wheat in the spring is very thin, flax is frequently sown on the field. In the spring of 1912, when the wheat fields were in very bad condition as a result of winterkilling, a large proportion of the wheat acreage in that locality was seeded with flax.

In this vicinity a 5-year rotation, consisting of corn, oats, wheat, timothy and clover, and timothy, is generally followed. Occasionally

[1] Issued Feb. 22, 1913.

flax is sown instead of oats. Sometimes the meadow is plowed up after one year and sometimes it produces hay for three years or more, but the rotation just described is the customary one.

How or when the practice of sowing flax in wheat originated has not been definitely determined. It has been followed around New London, however, for a period of approximately twenty years. Although careful inquiry has been made, no information has been obtained that flax is sown on winter-wheat fields in any other locality in the United States. There is apparently no reason why the practice would not be applicable in other parts of the country where flax thrives and where wheat is subject to winterkilling.

CONDITIONS UNDER WHICH FLAX IS SOWN.

Ordinarily when wheat has been injured by winterkilling, the farmer either harvests a light crop that does not pay for the cost of producing it or else he prepares the soil for a crop of spring grain, which not only involves additional expense, but also often seriously interferes with his regular rotation of crops. It is under such conditions that the practice of sowing flax in the wheat field has been found to be a means of avoiding loss and interference with the regular system of crop rotation.

It is a common practice of the farmers in the vicinity of New London to sow timothy seed at the same time as the wheat. The weather conditions in the fall of 1911 were very favorable for the growth of the timothy seedlings. In the spring of 1912 there was such a well-developed stand of timothy in some of the wheat fields that it was evident that the fields would produce a good crop of mixed wheat and timothy hay or, if left to mature, a light crop of wheat and a fair crop of timothy seed. Flax is not sown, as a rule, in fields where the indications are that the timothy will produce a fair crop.

SEEDING.

The flax is generally sown about April 1, or as soon as the weather has become warm enough to be favorable for plant growth and danger of freezing weather is past. Light frosts that sometimes occur after the flax seedlings are up do not seem to harm them. The seed is sown as early as it is safe to do so; otherwise, the flax does not mature until somewhat later than the wheat. When the flax is sown as early as April 1 it matures in time, so that there is practically no loss of wheat through shattering, as is the case when it is sown after the middle of April.

The flax is ordinarily sown broadcast with one of the various types of hand seeders. A few farmers mix the flax with timothy and clover and sow them together. As a rule the flax is sown separately and sometimes at a later date than the clover.

Flax germinates very readily. The farmers sow the seed without harrowing the soil either before or after sowing. When the first rain occurs, the seed germinates and usually makes a good stand. A light harrowing, however, would no doubt be beneficial to both the flax and the wheat.

When a flax crop is grown alone, the farmers in this vicinity generally sow 1 bushel of seed to the acre. When the flax seed is sown on winter-wheat fields, different farmers sow amounts of seed varying from 2 to 4 pecks per acre. The quantity of seed sown also depends somewhat upon the extent to which the wheat has been winterkilled.

HARVESTING.

As the wheat ripens somewhat earlier than the flax, the crop is harvested as soon as possible after the flax is mature. As has already been stated, the date at which the flax is ready to harvest depends largely upon the date on which the seed was sown.

As flax matures, its stems become woody, so that it is comparatively difficult to cut. The knives of the machine used must therefore be sharp. Flax is harvested in various ways. Farmers who own a drop-rake reaper usually use that machine. Where there is a large proportion of wheat growing in all parts of the field in mixture with the flax, a binder does excellent work. In fields where the flax predominates, the binder does not work so well. Where the flax grows alone, particularly if it is short and fine, it tends to get under the canvas and become wound around different parts of the machine, so that it sometimes becomes necessary to stop the machine and remove the flax.

Most of the flax grown in this locality is cut with a mowing machine, with an attachment behind the cutting bar which leaves it in light windrows, out of the way of the horses' feet and the wheels of the mower when the next swath is cut. By means of a 1-horse wheel rake, two windrows may be gathered at once into small bunches, where the flax lies until dry. The flax may be loaded, preferably with large wooden forks, on hayracks and hauled directly to the thrashing machine or stored in a barn or stack until it can be thrashed.

THRASHING AND SEPARATING THE SEED.

The wheat and flax mixture is thrashed in the same way that wheat alone is thrashed. They go through the same sieves and come out through the grain spouts together. The two kinds of seed are later separated with a fanning mill. The work of separating is usually done at the grain warehouse by the dealer who purchases the seed.

When a mixture of flax, wheat, and timothy is thrashed the timothy seed is separated by the sieves from the flax and the wheat and comes out beneath the machine.

The cost of thrashing is determined by the proportion of flax and wheat after the seed has been separated. In this locality the thrashers charge 12½ cents per bushel for thrashing flax and 4 cents per bushel for wheat.

YIELDS.

The yield of flax and wheat depends upon several factors. Soil and climatic conditions, as well as the relative thickness of the stand of flax and wheat, are important.

In Table I are given the yields harvested from several typical fields in 1912. It should be understood that neither the area of the fields nor the yields were measured exactly: the figures are quoted from the statements of the farmers growing the crop and are no doubt approximately correct.

TABLE I.—*Yields of flax, wheat, and timothy on several farms near New London, Ohio, in 1912.*

Field No.	Area.	Yield.			Field No.	Area.	Yield.		
		Flax.	Wheat.	Timothy.			Flax.	Wheat.	Timothy.
	Acres.	*Bushels.*	*Bushels.*	*Bushels.*		*Acres.*	*Bushels.*	*Bushels.*	*Bushels.*
1	25	250	137	.....	5	6	39	4	8
2	10	93	16	.....	6	6½	46	13	6
3	18	39	37	32	7	6	60	8	.....
4	6½	40	25	3	8	9	63	40	.....

The average yield of flax on the eight fields was 7.2 bushels per acre, and of wheat 3.2 bushels. From four of the fields an average yield of 1.3 bushels of timothy seed per acre was also obtained. At the time when most of the crop was sold flaxseed was worth $1.48, wheat $1, and timothy seed $1.25 per bushel. The average total income per acre, therefore, from the eight fields was $14.64. The average value of the flax on the eight fields was $10.65 per acre, and of the wheat $3.20.

While $14.64 per acre is not a large income, it is much better than would have been obtained from any one of these wheat fields in 1912 if the flaxseed had not been sown.

The yields of both wheat and flax were smaller in 1912 than have been obtained on several farms in this vicinity in former years. The price of flaxseed and timothy seed was also lower than it has ordinarily been in recent years. Several farmers have harvested yields of flax and wheat the value of which has been equal to that obtained from a good crop of wheat growing alone. One farmer produced

approximately 11 bushels of flax and 13 bushels of wheat to the acre. Another farmer harvested from a 9-acre field 11 bushels of flax and 6½ bushels of wheat per acre. A third farmer produced 12 bushels of flax and 9 bushels of wheat to the acre.

UTILIZATION OF SEED AND STRAW.

The flax seed is usually sold to a local grain dealer. It is then shipped to mills which manufacture linseed oil and linseed meal.

Large quantities of thrashed flax straw produced on fields where the flax has been grown alone are sold at a local tow mill. When the flax is grown in mixture with wheat, however, it can not be used for making tow unless it contains only a very small proportion of the wheat straw. The price of clear flax straw is at present $8 per ton. Flax straw containing a small amount of wheat or timothy was sold from a few farms for $7 per ton. As a rule, the mixed flax and wheat straw is retained on the farm, to be used for bedding or to be fed in the barnyard to stock during the winter.

EFFECT OF THE FLAX ON THE WHEAT, TIMOTHY, AND CLOVER.

It is the general opinion of those farmers who have sown flax in their wheat fields that the amount of wheat produced is not appreciably decreased by the presence of the flax. In those spots in the field where there may be a good stand of wheat plants the flax seedlings make only a small growth. In those portions of the field where the wheat has been winterkilled weeds would grow if the flax were not present.

Timothy and clover are sown in a field where flax is growing in mixture with the wheat in the same way that they are sown with wheat growing alone. Many good meadows have been obtained where timothy and clover have been seeded with wheat and flax.

CONCLUSION.

This method of sowing flax in wheat fields is not recommended as a regular farm practice. It is merely a plan that may be resorted to in years when wheat has been injured by winterkilling. After being given a trial of 15 or 20 years in the locality where the method was originated it is looked upon as one of the best ways to make use of a wheat field that has been injured by winterkilling. There is apparently no reason why it could not be adapted to a large proportion of the winter-wheat area throughout the Eastern and Central States, where it could be made a means of decreasing the loss that frequently occurs in seasons following a winter unfavorable to the wheat crop.

EXPERIMENTS IN SUBSOILING AT SAN ANTONIO.[1]

By S. H. Hastings, *Farm Superintendent*, and C. R. Letteer, *Assistant, Office of Western Irrigation Agriculture.*

INTRODUCTION.

San Antonio, Tex., is in what is classified as a semiarid region, the normal annual rainfall, as shown by the records of the United States Weather Bureau for the years 1891 to 1910, inclusive, being 24.77 inches. Because of the irregularity of the rainfall, the compact character of the soil, which during torrential rainstorms causes a large loss in surface run-off, and the high evaporation as compared with more northern sections, soil moisture is one of the most important limiting factors in crop production. Any farm practice, therefore, which will result in increased moisture content of the soil will be of much importance to the agriculture of the region. It is popularly thought that subsoiling will effect this and by so doing will increase crop production.

Subsoiling consists in loosening the soil to a depth greater than it can be loosened with an ordinary plow. This is accomplished by a subsoil plow, which operates in the bottom of the furrow left by a breaking plow, loosening the soil to the additional depth of about 12 inches. It requires a 2-horse or 3-horse team and a man to perform the operation, in addition to the man and team that do the plowing, so that the cost of plowing and subsoiling is practically double what is required for ordinary breaking. It is readily seen that the practice is an expensive one, and adds so much to the cost of preparation for a crop that unless it results in materially increased yields it can not be profitably followed as a regular farm practice. The cost of subsoiling at San Antonio has been found to be practically the same as plowing, or about $2 per acre.

SOIL CONDITIONS OF THE REGION.[2]

San Antonio lies in the southern extension of what is known as the Black Prairie region, or the Black Lands of Texas, and near the northern edge of an area known geologically as the Rio Grande

[1] Issued Feb. 22, 1913.

[2] See Circular 34, Bureau of Plant Industry, U. S. Department of Agriculture, entitled "The work of the San Antonio Experiment Farm in 1908."

Plain. The soil is mostly the result of weathering of limestone rocks of the Upper Cretaceous period. Recent alluvial deposits have been washed down from the higher lands northwest of the city, resulting in local modifications through the addition of coarser material. The typical soil is a heavy black or brownish clay or clay loam.

The lime content of the soil is unusually high, the proportion of lime in the upper 12 inches of soil varying from 7 to 23 per cent. This lime occurs in the soil both as finely divided material and as gravelly concretions. In the former condition it is generally dark colored through staining by decomposed organic matter, while in the latter condition it is usually white.

TEST OF SUBSOILING IN ROTATION AND TILLAGE EXPERIMENTS.

In order to determine the effect of subsoiling upon crop yields and upon the moisture content of the soil at San Antonio, subsoiling tests as a part of the rotation and tillage experiments were begun on the San Antonio Experiment Farm in the fall of 1909. This rotation and tillage work is conducted on 82 plats, each one-fourth acre in size. Three years' results have been obtained with subsoiling, and it is believed that these results are sufficiently conclusive to justify their publication. Corn, cotton, oats, grain sorghums, and saccharine sorghums are the crops grown in the rotations. The varieties of the various crops referred to in this paper are as follows: Corn (Laguna), three years; oats (Appler's Rustproof), three years; cotton (Triumph), 1910 and 1911, (Acala), 1912.

Those rotations in which subsoiling has been tested are shown in Table I. The lists are so arranged that the rotations opposite each other are directly comparable, the only difference in treatment being that of subsoiling or its omission.

TABLE I.—*Lists of rotations in which subsoiling has been tested at San Antonio Experiment Farm.*

Yr.	Not subsoiled.	Subsoiled.
	Rotation A5–D:	Rotation A5–E:
1	Oats for grain, cowpeas; plow under cowpeas in fall.	Oats for grain, cowpeas; plow and subsoil in fall.
2	Cotton; plow in November.	Cotton; plow in November.
3	Corn, cowpeas, manure; plow under cowpeas in fall.	Corn, cowpeas, manure; plow cowpeas and subsoil in fall.
4	Cotton; plow in November.	Cotton; plow in November.
	Rotation A6–A:	Rotation A6–C:
1	Corn, plow in July.	Corn; plow in July.
2	Oats for hay; plow in May.	Oats for hay; plow and subsoil in May.
	Rotation B6–A:	Rotation B6–B:
1	Corn: plow in July.	Corn; plow and subsoil in July.
2	Cotton; plow in November.	Cotton; plow and subsoil in November.
	Rotation B6–D:	Rotation B6–E:
1	Corn, cowpeas, manure; plow cowpeas in fall.	Corn, cowpeas, manure; plow cowpeas in fall.
2	Cotton; plow in November.	Cotton; plow and subsoil in November.
	Rotation B6–G:	Rotation B6–H:
1	Corn; plow in February.	Corn; plow and subsoil in February.
2	Cotton; plow in February.	Cotton; plow and subsoil in February.

EFFECT OF SUBSOILING ON CROP YIELDS.

Table II shows the effects of subsoiling on the yields of corn, cotton, and oats.

TABLE II.—*Average yield of crops in rotations subsoiled and rotations not subsoiled at the San Antonio Experiment Farm, 1910 to 1912, inclusive.*

Rotation Nos.	Not subsoiled.	Subsoiled.	Gain (+) or loss (−).	Rotation Nos.	Not subsoiled.	Subsoiled.	Gain (+) or loss (−).
CORN (BUSHELS PER ACRE).				COTTON (POUNDS OF SEED COTTON PER ACRE).			
A5–D and A5–E	13.0	14.0	+1.0	A5–D and A5–E	487.3	436.7	− 50.6
A6–A and A6–C	24.8	22.2	−2.6	A5–D and A5–E	509.3	526.0	+ 16.7
B6–A and B6–B	21.1	18.7	−2.4	B6–A and B6–B	561.7	501.3	− 60.4
B6–D and B6–E	21.2	20.6	− .6	B6–D and B6–E	614.0	643.3	+ 29.3
B6–G and B6–H	20.9	17.9	−3.0	B6–G and B6–H	574.7	502.0	− 72.7
Average	20.2	18.7	−1.5	Average	549.4	521.9	− 27.5
Average of 10 rotations:				Average of 10 rotations:			
1910	10.8	7.2	−3.6	1910	426.6	397.6	− 29.0
1911	11.9	11.8	− .1	1911	507.2	490.4	− 16.8
1912	37.9	37.0	− .9	1912	714.4	677.6	− 36.8
3-year average	20.2	18.7	−1.5	3-year average	549.4	521.9	− 27.5
OATS (BUSHELS PER ACRE).				OATS (POUNDS OF HAY PER ACRE).			
A5–D and A5–E:				A6–A and A6–C:			
3-year average	11.5	11.7	+ .2	3-year average	3,557	3,121	− 436
Average of 2 rotations:				Average of 2 rotations:			
1910	5.1	3.8	−1.3	1910	2,056	2,344	+ 288
1911	5.4	6.2	+ .8	1911	3,056	1,964	−1,092
1912	24.1	25.0	+ .9	1912	5,560	5,056	− 504

SUMMARY OF AVERAGES.

Crop.	Yield per acre.			Yield expressed in percentages of untreated plats.		
	Not subsoiled.	Subsoiled.	Gain (+) or loss (−).	Not subsoiled.	Subsoiled.	Gain (+) or loss (−).
Corn.....bushels	20.2	18.7	− 1.5	100	92.6	− 7.4
Cotton.....pounds	549.4	521.9	− 27.5	100	95	− 5
Oats, grain.....bushels	11.5	11.7	+ .2	100	101.7	+ 1.7
Oats, hay.....pounds	3,557	3,121	−436	100	87.7	−12.3
Average				100	94.25	− 5.75

From the foregoing table it is seen that in four rotations subsoiling has decreased the yields of corn and in one rotation it has slightly increased the yield. The cotton yields have been increased in two rotations and decreased in three rotations. In those portions of the table showing the average yield by years it is seen that subsoiling gave decreased average yields of corn and cotton in each of the three years. The summary shows that when the three-year average for all crops concerned is taken into consideration, subsoiling has decreased the yield of all crops except oats for grain. Since the tests with oats have not been so extensive as with other crops, it is doubtful whether this result can be taken as conclusive.

RESIDUAL EFFECT OF SUBSOILING ON THE YIELDS OF CORN AND COTTON.

In order to call attention to the possible residual effect of subsoiling on succeeding crops for several years after the operation, Table III has been compiled to show the effect of subsoiling on the yields of corn and cotton where the length of time intervening between the time of subsoiling and that of planting varies from 1 to 16 months.

TABLE III.—*Effect of different lengths of time between subsoiling and planting on the average yield of corn and cotton at the San Antonio Experiment Farm.*

Crop.	Gain or loss, per acre, due to subsoiling.		
	15 to 16 months.	3 to 8 months.	1 to 2 months.
Corn.....bushels..	+1.3	− 1.5	− 3.1
Cotton.....pounds..	+7	−31.4	−72.7

There is a marked decrease in the yields of both corn and cotton where the subsoiling was done from 1 to 2 months before planting, and a decrease where the subsoiling was done from 3 to 8 months before planting, while when the subsoiling was done from 15 to 16 months before planting there was a very slight increase. While these results are not at all conclusive, owing to the fact that the experiments cover only two years and the number of plats is limited, yet they are suggestive. The figures in this table indicate that loosening the subsoil is detrimental the first few months and also at the end of over a year, when under ordinary conditions if there was to be any resulting benefit it should be apparent. During the intervening period between subsoiling and planting, a crop was grown and the land replowed, and it would be supposed that any unfavorable soil conditions brought about by subsoiling would have time to readjust themselves during the period. Yet the increase in average yields as shown by the table is so slight as to indicate very little resulting benefit from the operation. In no case was the increase sufficient to cover the expense of subsoiling.

EFFECT OF SUBSOILING ON THE MOISTURE CONTENT OF THE SOIL.

Determinations of soil moisture were made at regular intervals of about one month on rotations B6–A and B6–B for a period of two years. Table IV shows the percentage of moisture in plat B6–1 as compared with B6–3, and B6–2 as compared with B6–4; also the crops grown on each plat each year and the time of plowing or subsoiling. The soil samples for moisture determinations were taken by means of the standard soil tube, two cores being taken on each plat and composited to a single sample. This composite sample was then weighed, dried, and weighed again, and the percentage of moisture computed on the basis of dry soil.

TABLE IV.—*Average moisture content in land subsoiled and land not subsoiled at the San Antonio Experiment Farm.*[1]

Sampled.	Crop and year.	Plat B 6–1.		Plat B 6–3.	
		Plowed.	Moisture content.	Plowed and subsoiled.	Moisture content.
1910.					
Nov. 21		November	10.9	November	11.7
Dec. 27		do	13.3	do	11.6
1911.					
Jan. 12		do	12.4	do	11.0
Feb. 13		do	11.9	do	11.7
Mar. 11	Corn, 1911	do	12.4	do	10.3
Apr. 18	do	do	13.5	do	12.4
May 9	do	do	14.1	do	13.7
June 15	do	do	8.7	do	8.9
July 17	do	do	9.5	do	9.1
		1911.		1911.	
Aug. 17	do	Aug. 3	9.8	Aug. 15	9.5
Sept. 16	do	do	10.1	do	9.4
Nov. 16	do	do	17.3*	do	18.3*
Dec. 13	do	do	16.2*	do	16.7*
1912.					
Jan. 9	do	do	14.0	do	12.0
Feb. 9	do	do	16.6*	do	16.4*
Mar. 11	do	do	16.6	do	16.2
Apr. 17	Cotton, 1912	do	20.2*	do	19.6*
May 18	do	do	17.9*	do	17.8*
June 12	do	do	16.0	do	14.8
July 9	do	do	13.5*	do	12.6*
Aug. 22	do	do	10.5	do	9.2
Sept. 23	do	do	10.6*	do	10.3*
Oct. 24	do	do	14.7*	do	14.8*
Mean			13.0		12.4

Sampled.	Crop and year.	Plat B 6–2.		Plat B 6–4.	
		Plowed.	Moisture content.	Plowed and subsoiled.	Moisture content.
1910.					
Aug. 17-18	Corn, 1910	Aug. 1	10.2	Aug. 2	10.8
Sept. 19	do	do	9.1	do	9.2
Oct. 14	do	do	11.0	do	10.5
Nov. 21	do	do	11.3	do	9.6
Dec. 27	do	do	11.7	do	11.9
1911.					
Jan. 12	do	do	11.1	do	10.0
Feb. 13	do	do	11.5	do	11.6
Mar. 11	do	do	10.8	do	10.6
Apr. 18	Cotton, 1911	do	12.5	do	13.0
May 9	do	do	13.7	do	13.7
June 15	do	do	10.5	do	8.6
July 17	do	do	9.7	do	9.3
Aug. 17	do	do	10.1	do	8.3
Sept. 16	do	do	9.4	do	8.3
Nov. 16	do	do	16.6*	do	15.5*
		1911.		1911.	
Dec. 13	do	Dec. 11	15.0*	Nov. 29	16.2*
1912.					
Jan. 11	do	do	11.5	do	12.2
Feb. 9	do	do	16.9*	do	15.2*
Mar. 11	Corn, 1912	do	15.3	do	16.7
Apr. 17	do	do	20.5*	do	18.9*
May 18	do	do	17.1*	do	16.7*
June 12	do	do	11.5	do	12.6
July 9	do	do	11.3*	do	10.8*
Aug. 22	do	do	9.8	do	9.9
Sept. 23	do	do	10.9*	do	9.2*
Oct. 24	do	do	15.2*	do	15.1*
Mean			11.9		11.6

[1] Each moisture determination marked with a star (*) is an average of 3 feet; all others are averages of 6 feet.

Table IV shows that in only a very few instances has the percentage of moisture in subsoiled land been greater than that in land not subsoiled, while in most instances it has been somewhat less. The means were obtained, not from the monthly averages, but by considering the entire number of samples taken during the sampling period. In both pairs of plats the averages indicate a larger percentage of soil moisture in land not subsoiled than in the subsoiled land.

CONCLUSIONS.

(1) Subsoiling is an expensive practice and so adds to the cost of preparation for a crop that unless materially increased yields result it can not be profitably adopted as a regular farm practice.

(2) Subsoiling has been tested at the San Antonio Experiment Farm for three years in rotation experiments with corn, cotton, and oats for hay and for grain.

(3) The yields of corn, cotton, and oats for hay and for grain have been either slightly increased or slightly decreased on subsoiled land. In no instance has the difference been significant.

(4) The depressing residual effect of subsoiling on the yields of corn and cotton was most marked when the crop was planted from 1 to 8 months after subsoiling; 15 months after subsoiling but little depressing effect was noted.

(5) In the soil-moisture studies so far made at San Antonio it has been found that subsoiling has not increased the moisture content of the soil.

(6) The results of these tests indicate that since neither the moisture content of the soil nor the yields of corn, cotton, and oats are increased by subsoiling, the practice is not advisable in connection with the crops mentioned in the San Antonio region of Texas.

CONTROL OF THE BLACK-ROT AND STEM-ROT OF THE SWEET POTATO.[1]

By L. L. Harter, *Pathologist, Cotton and Truck Disease and Sugar-Plant Investigations.*

INTRODUCTION.

This article outlines some of the precautions necessary to reduce the widespread loss of the sweet-potato crop by the black-rot [2] and stem-rot [3] organisms. Several papers on sweet-potato diseases are in press or in preparation, but as they will not appear before the coming planting season the following brief suggestions are published for the information of the growers interested. It should be stated at the outset that the following recommendations are merely tentative and may require modification when experiments that are now under way are completed. They include, however, what is believed at the present time to be the most effective means of control.

While there are a number of diseases of sweet potatoes, the most important are stem-rot, or yellow rot, and black-rot, or black shank. Both of these diseases affect the stem and roots of the plants.

Stem-rot is characterized by a blackening of the fibrovascular bundles of the plant, which can be readily recognized by pinching open the epidermis. The organism enters the potato at the stem end and is visible there by the blackened ring just beneath the epidermis.

Black-rot affects the plant from a little above the soil line down into the ground, causing a black, rotted appearance of the affected part of the stem. On the potato it appears as a black circular spot, which greatly enlarges in storage. These two diseases, then, find most congenial surroundings in the roots, or, in other words, in the "seed."

Experiments and observations have shown that both the field and hot bed are very common sources of infection. To control these diseases three things are therefore imperative: (1) Clean seed, (2) the hotbed and surroundings must be free of the organisms, and (3) the plants must be set on soil where these parasites are not present. If it is possible to meet these requirements the crop should be free from disease.

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[1] Issued Feb. 22, 1913.

[2] *Sphaeronema fimbriatum* (Ell. and Hals.) Sacc.

[3] *Fusarium batatatis* Wollenw. Mss.

SEED SELECTION.

It is now the practice among the better growers to select the seed potatoes at digging time for the next year's crop. Others, however, prefer to do it in the winter or in the spring. The best practice is to select seed potatoes in the fall at digging time and then examine them carefully again in the spring when starting the hotbed and discard all that show any symptoms of stem-rot or black-rot.

It is extremely difficult to tell during the winter or spring without a very careful examination whether a potato is affected with stem-rot. It is comparatively easy, however, to do so in the fall with the vines attached. Before any seed potatoes are selected from a hill, the main stem just above the potatoes should be carefully examined to see that it is not blackened inside and any suspicious hills should be rejected. The selected seed potatoes should be stored in crates or baskets and kept separate from the general stock. Seed potatoes should be disinfected with a corrosive-sublimate solution (formaldehyde gas or formaldehyde solution should not be used), 1 part of corrosive sublimate to 1,000 parts of water, for about 20 minutes, rinsed in water, and then thoroughly dried. They may be disinfected either in the fall or spring, but preferably in the fall.

THE HOTBED.

With clean seed potatoes it is essential that the hotbed should be free from parasitic organisms. Great care should be exercised in the preparation of the hotbed. Before the soil is put in the bed, the cement, boards, or whatever is used in the construction should be thoroughly sprayed with a solution of 5 pounds of copper sulphate to 50 gallons of water and then with a Bordeaux mixture, or whitewashed. In some localities where these diseases are very prevalent it is almost impossible to find soil that is not infested. Fields which had not been grown to sweet potatoes for nearly 40 years have given an infected crop when clean slips were used. Where such a general infection has occurred the soil is light and it is probable that the organisms were distributed by the wind. In view of these facts it is advisable to disinfect all hotbed soil. This can be done in two ways: (1) By steam sterilization and (2) by treating with a solution of formaldehyde.

Steam sterilization is preferable when possible. When disinfecting by steam, any system can be used that insures the greatest efficiency with the least expenditure of time and money. Efficiency, however, should be the first consideration. It is a useless expenditure of time and money to sterilize if it is not done thoroughly or, if after once being thoroughly sterilized, the soil is allowed to become infested by

handling with shovels or by placing it in boxes, etc., that have not been disinfected.

Some system patterned after the following plan is suggested by Mr. W. W. Gilbert and, with such modifications as are necessary to meet local conditions, may be found feasible. A stationary or portable engine must be available which can stand a pressure of 80 to 100 pounds of steam. If a stationary engine is used, the soil must be hauled to the engine for sterilization. In such cases it will be found convenient to construct a strong box which can be tightly covered, sufficiently large to hold 1, 1½, or 2 tons or more of soil, with 1½ to 2 inch perforated iron pipes (the perforations to be about three-sixteenths of an inch in diameter and 6 inches apart on the under side) laid in the bottom about 1 foot apart, which can be attached to the engine by a pipe or steam hose. This is easy to accomplish by connecting the parallel rows of pipes in the box with a header having an outlet connecting with the engine. This box should be loaded on a wagon and hauled to the farm and filled; then brought to the engine and sterilized and again returned. If there is any general demand for soil sterilization, several completely equipped boxes will be needed. The use of portable boxes is advisable merely to protect against reinfestation of the soil after it is sterilized.

It will be more convenient to have a stationary sterilizing box and haul the soil to and from it in a wagon if the necessary care is taken to wash out the wagon box with a formaldehyde solution before the sterilized soil is again put in it. This method will save time, labor, and expense. The soil can then be brought to the engine, scooped into the box, spread out 8 or 10 inches deep over the pipes, sterilized, and returned to the wagon. Practically the same methods can be employed if a portable engine is used to sterilize the soil on the farm.

When the pressure is up to about the capacity of the engine, probably 80 to 100 pounds, the steam should be turned on by opening the valve about half way. The higher the pressure the drier the steam. The soil should be sterilized for about 40 minutes after the temperature reaches 100° C. (212° F.). The thermometer should be placed in the soil midway between the pipes.

If it is impracticable or impossible to sterilize with steam it may be done by the use of a formaldehyde solution, 1 pint of formaldehyde (40 per cent) to 24 gallons of water. Formaldehyde is cheap and can be purchased at almost any drug store. When the soil is to be treated with a formaldehyde solution it should be placed in a tight box or other receptacle and enough of the solution added to soak it thoroughly. The application should be made at least two weeks before the soil is to be used, in order to allow the formaldehyde to evaporate. An occasional stirring of the soil will assist in the escape

of the gas. Disinfected soil should be carefully protected to prevent infestation before it is used. All instruments used in handling sterilized soil, such as the wagon box, shovels, etc., should be disinfected.

It is believed by some farmers that better and stronger plants can be secured by using manure as a source of heat in the hotbed. Others insist that equally good, if not better, plants can be grown in a fire bed. Which is right must remain unsettled, at least till reliable experimental evidence is produced. From the standpoint of disease, there is far greater danger, however, from the use of manure, especially if it is produced on farms where sweet potatoes are grown. It frequently happens that farmers are careless about the disposition of decayed sweet potatoes and feed them to hogs or chickens or, more often, throw them on the manure pile. From there they are carried to the hotbed, and infection of the young plants becomes easy. It is urged that all refuse sweet potatoes be cooked and not thrown where they will be scattered in the manure and hauled on the farm or used in the hotbed.

CROP ROTATIONS.

It is not known how long black-rot and stem-rot will live in the soil without the sweet potato as a host. It is advisable, however, to follow a system of crop rotation that will not bring this crop on the same ground oftener than once in three or four years. It is certain that the crop will not be free from disease so long as the organisms are present in the fields. The only way to get them out of the field is to starve them out by planting crops on which they can not live. Experiments, however, have shown that the percentage of diseased plants is much reduced by planting healthy slips, although the soil may be infested. This fact alone justifies all the precautions necessary to grow healthy slips, even though the soil on which they are planted is diseased.

BARTLETT PEAR PRECOOLING AND STORAGE INVESTIGATIONS IN THE ROGUE RIVER VALLEY.[1]

By A. V. Stubenrauch, *Pomologist in Charge*, and H. J. Ramsey, *Pomologist in Fruit Transportation and Storage Investigations, Office of Field Investigations in Pomology.*

INTRODUCTION.

There are now approximately 50,000 acres of pear trees in the Rogue River Valley of Oregon and planting is still in progress. By far the major portion of the acreage consists of Bartletts. At present only a small percentage of the trees are in bearing. When the new plantings come into full bearing the production of pears in the valley will assume large proportions, and the problems of successfully marketing the large crop therefore become of pressing importance. The general experience thus far has been that Bartlett pears shipped during the first half of the season do not bring as much in the eastern markets as later shipments. This is due to the fact that they usually arrive in the markets of the East at a time when California pears of excellent quality are very plentiful. As soon as the bulk of the California crop is out of the way the demand for Rogue River Valley Bartletts increases, and the prices received are considerably higher. The extension of the season during which Bartletts can be marketed in good, sound condition is therefore of the greatest importance to the industry of the Rogue River Valley and wherever these pears are grown in the Pacific Northwest.

PRECOOLING AND STORAGE EXPERIMENTS.

With a view of determining whether the usual Bartlett pear season of the Northwest could be extended or lengthened sufficiently to enable the bulk of the crop to reach eastern markets after the California season closes, investigations were begun in the Rogue River Valley during the season of 1912. These investigations, undertaken at the urgent request of growers and shippers, included a study of the practicability of extending or lengthening the marketing season by precooling and storage at the producing end. The work also included a study of the relation to decay in storage and in

[1] Issued Feb. 22, 1913.

transit of the maturity of the fruit at the time of picking, immediate and delayed cooling and storage, and methods of handling in the orchards and packing houses. Up to last season little had been done, at least in a systematic way, with the precooling and storage of Bartlett pears in the valley. Usually the fruit is shipped out as soon as possible after picking and packing, although it is often delayed two to four days and sometimes longer, either loose or packed, in the packing houses before it is loaded into refrigerator cars. After arrival in the eastern markets, fruit handled in this way must be sold immediately or else placed in cold storage. Most of the attempts to store Bartletts in the East after shipment across the continent have not been very successful or encouraging. Too much time elapses between picking and storing, and the fruit is often exposed to high and variable temperatures while in transit.

DESCRIPTION OF THE EXPERIMENTS.

Pickings were made from three different orchards in sections representing three different types of soil. Four pickings were made from each orchard at intervals of a week, the first just before the regular commercial pickings were started and the last fully a week after the usual Bartlett season had come to an end. Thirty-two boxes of fruit were picked at each picking from each orchard, making 384 boxes in all.

In order to test the effect of precooling before and after packing, half of each pick (16 boxes) was packed as soon as possible after picking and the other half was held loose in the "lug" or picking boxes. Half of each packed and loose lot was placed in the cooling room immediately after picking or packing, while the other half was held for two days before cooling. In the discussion which follows the former are referred to as "immediately cooled" and the latter as "delayed."

The precooling and storage tests were made in three rooms rented from the Medford Ice and Storage Co., one room being used for precooling, one for packing, and the other for storage.

The fruit was picked by regular pickers under the supervision of representatives of the Bureau of Plant Industry. Some of the fruit was packed by regular packers, but most of this work was done by the Bureau men. When the pears were placed in the precooling room the temperature of the room was usually about 20° F., but it increased slightly after the warm fruit was put in. Actual fruit temperatures were taken before placing the pears in the precooling room and during the cooling by means of thermometers inserted into fruits, both near the center and toward the outside of the package. When the temperature of the outer fruit in the packed boxes and the loose fruit in the lug boxes approached 32° the room temperature was

allowed to rise to 30° or 32° to avoid freezing, and was held there until the inner fruit was reduced to 34° or lower. No forced air circulation was used. The loose fruit in the lug boxes cooled to the desired temperature in less than half the time required for wrapped packed fruit. The cooling was also decidedly more uniform. In the packed boxes it often required three times as long to cool the fruit in the center of the box as was needed for the outer fruit in the same box. This necessitated the maintenance of a room temperature not lower than 30° or 32° after the outer fruit was cooled. The rate of cooling was necessarily slower under these conditions.

Four withdrawals from each lot were made—after one, two, three, and four weeks, respectively. After withdrawal, the various lots were placed in an iced refrigerator car held at Medford, as it was impracticable to make any shipping tests during the season. Each lot was held in the refrigerator car for 12 days, this being about the average time required for carload lots to reach New York. As precooled and cold-stored fruit is cool when placed in the refrigerator car for shipment unless allowed to warm materially during the transfer to the car, holding small lots in a stationary iced car should approximate transit conditions in everything except jolting and the possible influence of fluctuating outdoor temperatures while en route. When cold fruit is placed in refrigerator cars, whether in carload lots for shipment or in small lots for holding tests, the ice has only to supply sufficient refrigeration to hold the fruit at a low temperature; when warm fruit is placed in the car the ice must supply refrigeration both to reduce the initial temperature of the fruit and to keep it cool. After withdrawal from the car the experimental lots were placed in an ordinary warehouse held under approximately open-market conditions. Inspections were made at the time of withdrawal from the car and at the end of market-holding periods of five and eight days.

The total deterioration, as recorded by actual inspection of every fruit in each box, included (1) wilt or shriveling, (2) brown stain or scald, (3) fungous decay, (4) partial physiological decay, and (5) complete physiological decay.

Wilting or shriveling always started at the stem end, and all wilting or shriveling sufficiently noticeable to be taken into account on the market was recorded. Brown stain or scald is a term used to designate a general browning of the skin, at first only a discoloration, but gradually extending into the fruit and causing browning and softening throughout. When recorded in the inspections the discoloration was only on the surface of the skin, and fruits so affected soon softened and were worthless 24 hours after inspection. Fungous decay includes all decay due to attacks of various fungi, most of which undoubtedly gained entrance through some bruising or

abrasion of the skin. Partial physiological decay is a term used to designate a darkening or browning at the core of the pear and could be determined only by breaking or cutting each individual fruit. All fruits recorded as showing this trouble were usually firm and of good eating quality. Complete physiological decay includes all fruits which were completely discolored, soft, and worthless.

At the first inspection, made when the fruit was withdrawn from the refrigerator car, all lots were practically as green as when they were placed in storage and showed no deterioration of any kind.

At the time of the second inspection, made on the sixth day after withdrawal from the car, some of the lots were even then so green that they were hardly in good eating condition, but nearly all were in prime fruit-stand condition. The third inspection was made on the ninth day after withdrawal from the car.

Analysis of the data from the second inspection shows that most of the deterioration, especially shriveling, fungous decay, partial physiological decay, and brown stain, occurred in the first pick. The second inspection of the immediately cooled lots of the fourth withdrawal from the third and fourth pick in no case showed even 1 per cent of any of the troubles described after the fruit had been held five days under market conditions. The delayed lots showed very little more. The third inspection of the fourth withdrawal, immediately cooled, third and fourth picks, showed the fruit to be practically sound, with the exception of 5.9 per cent and 18.3 per cent of partial physiological decay in the third and fourth picks, respectively. In the third withdrawal, second inspection of the first pick, there was 7.2 per cent of shriveling in the immediately cooled and 22.7 per cent in the delayed lots; while at the same inspection the immediately cooled fourth pick showed 0.2 per cent and the delayed 0 per cent, respectively. Practically all of the brown stain recorded (sometimes as much as 18 per cent) occurred in the first pick, with only a trace in the second and none at all in the third and fourth. The highest percentages of fungous decay (9.7 per cent in the immediately cooled and 15.2 per cent in the delayed, third inspection, third withdrawal) occurred in the first pick. Some was found in the second, but there was practically none in the third and fourth. The highest percentages of complete physiological decay found in each of the delayed lots of the third and fourth withdrawals, third inspection of the fourth pick, were 11.2 per cent and 12.8 per cent.

Temperature conditions during the time of holding in the warehouse apparently affected the percentage of partial physiological decay found in the second and third inspections of all lots. In the third withdrawal from the third pick, immediately cooled, third inspection, there was 70.6 per cent of partial physiological decay and but 5.9 per cent in the third inspection, immediately cooled, fourth

withdrawal of the same pick. In the third inspection of the immediately cooled lots, third and fourth withdrawals of the first pick, there was 79.2 and 91.7 per cent of partial physiological decay, respectively. The pears showing partial physiological decay were in fairly good condition for immediate consumption, being of good eating quality, but they deteriorated rapidly. Undoubtedly the great difference in partial physiological decay between the third and fourth withdrawals, third pick, third inspection, is due to the rather variable temperatures which occurred at the time these were held in the warehouse. No definite conclusions can be drawn from the inspections as regards cooling before and after packing. In general, the fruit cooled before packing appeared to be in slightly better condition, but not enough to warrant the expense such an operation would entail. Where fruit is cooled before packing, it can be cooled more quickly and uniformly.

The delayed cooled and stored lots showed considerably more wilting and shriveling and on an average more fungous decay and more complete physiological decay than the lots immediately cooled and stored. The delay of two days required for this work is no more than the average given Bartlett pears under commercial handling conditions.

RESULTS OF THE EXPERIMENTS.

While it is realized that the work here reported must be considered as only preliminary, indicating the scope which future investigations should follow, the results were striking and consistent throughout and sufficient data are at hand to warrant a full commercial test and demonstration of this method of marketing Bartlett pears in the Pacific Northwest. Further study is necessary in order to determine the factors of seasonal influence, which must be taken into consideration before all phases of the problem are solved.

The results indicate that the marketing season of Bartlett pears can be lengthened or extended six or seven weeks, provided some changes are made in the method of handling the crop.

The pickings as a rule should be made fully two weeks later than is the ordinary practice. At this time the fruit will be of larger size, of better quality, and in every way will hold up better in storage and in transit. There will be some dropping where the fruit is held on the trees two weeks longer, but this will largely be offset by the increase in size and the improvement in keeping quality. It is also of the greatest importance that the fruit be placed in storage or in an iced refrigerator car as soon as possible after picking, as a delay in cooling of even two days caused much more deterioration than occurred in fruit stored immediately, whether packed before or after cooling.

The results also indicate that the practice of picking the trees clean at one picking, especially early in the season, is not conducive to the best keeping quality and uniformity. Where only one picking is made, and that early, much of the fruit is picked while it is still immature, and this fruit will show a great deal of wilting, shriveling, brown stain or scald, and physiological decay, thereby detracting from the appearance of the pack and lessening the returns from the fruit which was of proper maturity when picked. The pickings can be extended over a longer time than is generally believed to be the case, and this is especially true where two, or possibly three, pickings are made during the season.

The results further indicate that when picked at the proper time and when carefully handled and promptly precooled, Bartlett pears stored for four weeks at the shipping point and afterwards loaded into pre-iced refrigerator cars and shipped to eastern markets will arrive in sound, marketable condition and remain sound for a sufficient time to allow reshipment and consequent wide distribution to ultimate consumers. The season can be extended from six to seven weeks by leaving the fruit on the trees two weeks longer than is at present the practice and by storing for four or five weeks at a temperature of 32° or 34° F. after the fruit has been precooled.

CLIMATIC CONDITIONS ON THE TRUCKEE-CARSON PROJECT.[1]

By F. B. Headley, *Farm Superintendent, Office of Western Irrigation Agriculture.*

INTRODUCTION.

Climate is an important factor in influencing the agriculture of any country and it also affects the comfort and health of the inhabitants. For this reason people proposing to settle in a new country are greatly interested in its climatic conditions.

This paper has therefore been prepared in order that the climatological data relating to the Truckee-Carson Project may be assembled in a convenient form for reference and to answer the inquiries of new and prospective settlers.

LENGTH OF SEASON.

Alfalfa is the great money-producing crop of the project. It starts growth in late March or early April and usually continues to grow without being severely checked. It sometimes happens, however, that the early growth is frozen back and the time of maturity of the first crop delayed. This occurred in the spring of 1911. It is interesting to note in this connection that some fields that had been irrigated by flooding during the daytime just preceding the freeze were uninjured.

Sugar beets, grain crops, onions, and hardy vegetables are planted in early spring, as they are seldom or never injured.

Potatoes are usually safe if planted after May 1, but all tender plants, such as melons and tomatoes, should not be planted in the open without protection until about May 20 unless some means of protecting them on cold nights is provided.

The blossoms of the fruit trees are frequently killed by the late spring frosts. This is particularly true with peaches and apricots. Apples and pears blossom later and are more frequently able to set a crop. It is probable that the crop of apples and pears can be saved by means of an equipment of orchard heaters.

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The season is sufficiently long to mature the quicker ripening varieties of corn, tomatoes, and melons, but it is not long enough for maturing long-season varieties.

FROSTS.

The length of the summer period between frosts is shown in Table I. This table is only approximately correct, for the reason that the dates of the killing frosts are reported from the different parts of the project by various individuals, who may have a diversity of opinion as to what constitutes a "killing" frost. The table will, however, be helpful in indicating approximately the length of the growing season.

TABLE I.—*Dates of killing frosts (last in spring and first in autumn) at various points on the Truckee-Carson Project, 1906 to 1912, inclusive.*

Locality and season of frost.	1906	1907	1908	1909	1910	1911	1912	Average for all years.
Carson dam:								
Last in spring	.....	Apr. 20	May 15	May 11	Apr. 22	[1] May 10	May 21	May 6
First in autumn	Sept. 4	Oct. 29	Sept. 26	Oct. 30	Oct. 13	Oct. 18	Sept. 5	Oct. 3
Leetville:								
Last in spring	.....	May 2	May 9	May 13	Apr. 12	.....	.....	May 1
First in autumn	Oct. 4	Sept. 19	Sept. 26	Sept. 22	Oct. 13	.....	.....	Sept. 29
Soda Lake:								
Last in spring	.....	.....	May 16	May 14	Apr. 15	May 6	[1] May 22	May 9
First in autumn	Oct. 18	Sept. 18	Sept. 25	Oct. 22	Oct. 13	Oct. 18	.....	Oct. 9
Fallon:								
Last in spring	May 31	May 14	May 30	May 24	May 16	May 27	May 22	May 23
First in autumn	Oct. 4	Sept. 19	Sept. 25	Sept. 22	Sept. 13	Oct. 18	Sept. 25	Sept. 27
Fernley:								
Last in spring	.....	June 14	May 8	May 28	Apr. 21	.....	[1] May 22	May 19
First in autumn	.....	Oct. 4	Sept. 26	Oct. 8	Oct. 13	Oct. 18	Sept. 25	Oct. 6

[1] Date on which temperature reached 32° F. or below is here given in lieu of other indication of date on which actual killing frost occurred.

The occurrence of frosts is markedly influenced by the local topography of the land. Observations made at the experiment farm in 1910, 1911, and 1912 show the extent of this influence in a typical location. Two registering minimum thermometers were placed 190 feet apart, one of them in a hollow between two long, low hills, and the other on the highest point of one of the hills at an elevation of 13½ feet above the level of the thermometer in the hollow. Table II shows the average difference in temperature during those months in which comparative records have been kept. The greatest difference occurred on those nights when there was little or no wind. A maximum difference of 10 degrees occurred on a few nights. No instance is recorded when the minimum temperature was higher in the hollow than on the hill. The results indicate that tender fruits and vegetables will be in less danger from injury when planted on the higher

lands having good air drainage than when planted in the bottom lands or hollows.

TABLE II.—*Average monthly minimum temperatures recorded by two thermometers, one on a hill and the other in a hollow, on the Truckee-Carson Experiment Farm in 1910, 1911, and 1912.*

Month.	1910			1911			1912		
	Hill.	Hollow.	Difference.	Hill.	Hollow.	Difference.	Hill.	Hollow.	Difference.
January							20.8	17.9	2.9
February							22.4	18.2	4.2
March							26.2	23.1	3.1
April	39.0	34.8	4.2	33.1	29.8	3.3	32.9	30.9	2.0
May	42.7	39.5	3.2	38.4	34.9	3.5	40.4	38.3	2.1
June				51.0	49.0	2.0	46.3	43.1	3.2
July				56.1	52.5	3.6			
August				49.8	44.5	5.3	49.4	45.5	3.9
September				40.6	36.6	4.0	40.8	37.5	3.3
October				31.8	27.3	4.5			
November				21.0	17.0	4.0			
December				13.3	9.9	3.4			

Table III, compiled from the records of the United States Weather Bureau, shows the average temperature conditions at Fallon, Nev., from 1906 to 1912, inclusive.

The absolute maximum temperature recorded in any year was 103° F., in August, 1908, and the minimum was 15° below zero, in January, 1910. July is the hottest month and January is the coldest.

TABLE III.—*Average and absolute monthly temperatures at Fallon, Nev., 1906 to 1912, inclusive.*

Month.	Absolute.		Mean.		
	Maximum.	Minimum.	Of maxima.	Of minima.	For month.
January	57.2	4.4	44.09	19.91	31.3
February	56.5	9.5	50.71	24.03	37.5
March	72.4	16.0	58.43	28.50	43.5
April	82.2	20.4	67.82	34.82	51.0
May	87.0	27.6	71.95	39.22	56.0
June	94.8	38.0	82.43	47.67	65.2
July	99.8	44.2	92.70	59.03	73.7
August	98.4	44.3	91.11	51.13	71.1
September	91.6	29.7	79.23	41.83	60.5
October	82.1	22.0	67.33	32.73	50.2
November	72.1	9.7	56.26	24.41	40.3
December	60.3	4.1	44.42	19.03	31.7

MINIMUM TEMPERATURES IN DIVERSE SECTIONS OF THE PROJECT.

In April, 1911, recording minimum thermometers were placed in different parts of the project, with farmers who volunteered to act as cooperators with the experiment farm in securing records of minimum temperatures. These cooperators are Miss Anna Johnson, in the Island district; W. W. Cogswell, on Summit ranch, 4½ miles

east of Fernley; and Walter Van Voorhis, superintendent of the Indian school, 11 miles east of Fallon. Official records for the Weather Bureau were kept at Fernley, Carson dam, Soda Lake, and Lahontan.

It was thought that a table showing minimum temperatures in diverse portions of the project might be of interest in relation to fruit growing, provided it is found that certain sections are more nearly free from frost than other parts of the project. Comparative temperatures, as far as they are complete, are shown in Table IV.

TABLE IV.—*Average monthly minimum temperatures in diverse portions of the Truckee-Carson Project in 1911 and 1912.*

Year and place.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1911.												
Experiment farm	23.4	28.2	30.7	30.7	36.4	50.0	55.0	48.7	39.1	30.7	20.4	12.7
Fernley	23.2	18.4	29.2	30.1	33.4	49.6	55.5	52.1	39.8	28.5	21.3	13.6
Soda Lake	24.6	20.9	32.6	34.9	39.0	53.2	.....	53.8	43.7	33.9	23.7	16.7
Carson dam	26.0	21.6	33.5	35.5	39.9	54.9	61.2	53.8	42.8	32.9	23.3	16.3
Island district	.....	.....	.....	31.2	36.6	48.0	52.2	47.1	37.0	26.6	18.1	10.1
Indian school	.....	.....	.....	.....	.....	.....	.....	.....	39.6	29.6	17.3	11.0
1912.												
Experiment farm	19.9	21.4	25.7	32.6	40.2	46.6	51.6	48.5	39.9	31.8	24.2	14.5
Summit ranch	.....	.....	28.9	34.5	44.3	51.4	58.0	56.3	.....	36.9	28.1	18.9
Fernley	21.4	23.2	25.1	32.2	40.3	46.6	55.1	52.5	41.3	31.0	22.8	15.0
Soda Lake	21.7	.....	.....	.....	42.6	.....	56.2	.....	.....	32.5	.....	.....
Carson dam	21.1	23.0	27.1	33.7	43.9	50.1	56.1	53.5	42.2	34.4	24.7	16.7
Lahontan	24.5	29.0	31.0	36.1	46.2	53.7	61.2	58.6	47.0	35.6	30.0	22.1
Island district	.....	.....	21.3	29.9	39.2	45.9	51.6	.....	36.6	29.3	.....	.....
Indian school	20.2	19.4	24.9	31.6	40.4	46.9	.....	48.6	42.1	[1]30.7	23.7	13.6

[1]Average for 30 days.

WINDS.

The wind is an important factor on a large part of the Truckee-Carson Project, especially in those sections where the soil is sandy and can be easily blown. The total annual wind movement for the project is not great, but heavy winds from the west or southwest occur occasionally in the spring and summer and are sometimes severe enough to kill new seedings of alfalfa and other tender crops.

Since the damage to the crops is due chiefly to the blowing of the sand, young crops may be planted quite safely on the east side of a field on which grain or alfalfa is growing, or small fields may be protected by hedges or brush fences along the west side. The planting of rows of trees along the west side of each farm is desirable on account of the protection they will give to the fields. As the fields of alfalfa increase in extent and the groves of trees in number and size the injurious effects of the winds will decrease. Table V shows that the highest average wind velocity occurs during the months of April and May.

TABLE V.—*Average monthly wind velocity, in miles per hour, at the experiment farm, Fallon, Nev., 1909 to 1912, inclusive.*

Month.	1909	1910	1911	1912	Average of years shown.	Month.	1909	1910	1911	1912	Average of years shown.
January	.....	2.2	4.6	3.2	3.33	July	3.7	3.2	3.2	3.6	3.43
February	.....	3.7	4.8	3.1	3.88	August	5.6	3.1	2.5	3.6	3.70
March	.....	4.5	3.6	5.6	4.57	September	3.8	2.9	3.4	3.5	3.40
April	.....	5.0	5.9	6.2	5.70	October	3.8	2.7	3.5	3.5	3.37
May	5.4	4.6	5.9	5.3	5.30	November	3.9	3.0	3.4	3.4	3.42
June	5.9	4.4	4.0	5.2	4.88	December	3.8	2.4	2.8	3.4	3.10

RAINFALL.

The rainfall in the region of the Truckee-Carson Project is so light that it is of little benefit to growing crops. Table VI gives the monthly precipitation for the seven years 1906 to 1912, inclusive.

TABLE VI.—*Monthly and annual rainfall at Fallon, Nev., 1906 to 1912, inclusive.*

Month.	1906	1907	1908	1909	1910	1911	1912	Average.
January	.....	0.39	0.49	0.60	1.98	0.96	0.13	0.76
February	.....	.30	.48	.25	.04	.69	.06	.30
March	.....	1.40	.02	.74	.10	.53	.37	.53
April	0.76	1.06	.28	.19	.28	.25	.87	.53
May	.72	.39	.92	.02	0	.02	.43	.36
June	.57	.66	.05	.27	.10	.55	.22	.35
July	.01	Trace.	.15	Trace.	.05	.09	.13	.06
August	Trace.	.38	.02	.06	0	0	.18	.09
September	.29	.12	.62	.41	.45	.04	.43	.34
October	Trace.	.41	.17	.70	.46	.03	1.10	.41
November	.44	.21	Trace.	.71	.02	Trace.	.08	.71
December	1.56	.48	.07	1.30	.66	.16	Trace.	.60
Total annual	.....	5.80	3.27	5.25	4.14	3.32	3.33	5.04

EVAPORATION.

The amount of evaporation from a free water surface depends chiefly upon three factors, namely, air temperature, humidity of air, and wind velocity. Table VII shows that the evaporation is greatest during the hottest months. During these months the surface of the soil dries out quickly, and farmers often find difficulty in getting seeds planted at this time to germinate before the surface soil dries out. In the spring while there is low evaporation it is not usually difficult to get seeds to come up without irrigation, but during the period of high evaporation it is often necessary to irrigate fields after seeding in order to get a good stand.

TABLE VII.—*Monthly and annual evaporation at Fallon, Nev., 1908 to 1912, inclusive.*

Month.	1908	1909	1910	1911	1912	Average.
January	.....	1.63	Frozen.	0.64	1.24	1.17
February	.....	2.34	Frozen.	1.33	2.13	1.93
March	.....	2.70	3.74	3.50	4.16	3.52
April	.....	5.37	6.22	6.49	5.66	5.93
May	7.91	8.28	8.15	8.07	6.68	7.82
June	10.22	9.93	11.73	8.35	10.39	10.12
July	11.74	10.70	11.16	9.96	9.64	10.64
August	10.84	9.23	10.24	9.66	9.03	9.80
September	5.50	6.46	5.78	6.47	6.07	6.06
October	4.00	3.51	3.61	3.92	3.43	3.69
November	2.27	2.28	2.00	2.15	1.97	2.13
December	.65	.91	.69	.61	.78	.73
Total	.....	63.34	63.32	61.15	61.18	63.54

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